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## THE COMPOSITION OF THE AVERAGE IGNEOUS ROCK<sup>1</sup>

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The composition of the "average igneous rock" has been computed by Clarke, Harker, and Washington. Clarke's most recent estimate was published in 1915.<sup>2</sup> The earlier computations were made by averaging the results of large numbers of analyses, and the later by averaging each constituent according to the number of determinations made, and reducing the sum to 100 per cent. The objection to these methods, as is well known, is that they take no direct account of the quantitative distribution of the rocks; each analysis or determination receives the same weight, regardless of the size of the geologic body that it is held to represent. The force of this objection has been recognized by Clarke,<sup>3</sup> who concludes that "the whole land surface of the earth must be taken into account before the true average can be finally ascertained."

A first approximation to this true average can be reached by calculations based on data recently assembled by Daly in *Igneous Rocks and Their Origin*. In Table IV is given the total areas covered by each of the rock species named and mapped in the Cordilleran and Appalachian folios of the United States Geological Survey. The area occupied by any rock species divided by the total area of igneous rocks (16,728 square miles) gives a weight-factor, and this factor multiplied by the average composi-

<sup>1</sup> Published with the permission of the Director of the U. S. Geological Survey.

<sup>2</sup> *Analyses of Rocks and Minerals from the Laboratory of the United States Geological Survey*, U.S. Geological Survey Bulletin, No. 591, pp. 18-22, 1915.

<sup>3</sup> *The Data of Geochemistry* (3d ed.), U.S. Geological Survey Bulletin, No. 616, p. 26, 1916.

tion of the species, which has been computed by Daly in Table II, gives the percentage contribution of that species to the composition of the average igneous rock. In this calculation species covering less than 2 square miles were omitted, as their inclusion would not affect the second decimal place of the result. The composition thus calculated is that of the average exposed igneous rock; whether it represents the composition of the average igneous rock of the 10-mile crust depends on the verity of certain petrogenic considerations.

The following proportional factors were used in the computations:

Granite, including allied porphyries . . . . .	0.23212
Granodiorite . . . . .	.12195
Rhyolite . . . . .	.12834
Andesite . . . . .	.23864
Basalt . . . . .	.20773
Quartz monzonite and allied porphyry . . . . .	.00108
Diorite . . . . .	.01802
Gabbro . . . . .	.02225
Anorthosite . . . . .	.00311
Syenite and syenite porphyry . . . . .	.00389
Monzonite . . . . .	.00161
Nepheline syenite . . . . .	.00024
Shonkinite . . . . .	.00054
Theralite . . . . .	.00036
Peridotite . . . . .	.00436
Pyroxenite . . . . .	.00011
Diabase . . . . .	.01602
Dacite . . . . .	.00536
Trachyte . . . . .	.00036
Latite . . . . .	.00030
Phonolite . . . . .	.00048
Nepheline melilite basalt . . . . .	.00018
Limburgite . . . . .	.00012
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Total . . . . .	1.00000

The result of the new calculation of the composition of the average igneous rock is given in column I of the accompanying table; for comparison, the most recent estimate by Clarke is given in column II.

Notwithstanding the widely different methods employed in the calculations the new estimate agrees to a remarkable extent with

COMPOSITION OF THE "AVERAGE IGNEOUS ROCK"

	I	II
SiO <sub>2</sub> .....	61.64	60.47
TiO <sub>2</sub> .....	0.73	0.80
Al <sub>2</sub> O <sub>3</sub> .....	15.71	15.07
Fe <sub>2</sub> O <sub>3</sub> .....	2.91	2.68
FeO.....	3.25	3.50
MnO.....	0.16	0.10
MgO.....	2.97	3.85
CaO.....	5.06	4.88
Na <sub>2</sub> O.....	3.40	3.41
K <sub>2</sub> O.....	2.65	3.03
H <sub>2</sub> O—.....	1.26	0.48
H <sub>2</sub> O.....		1.44
P <sub>2</sub> O <sub>5</sub> .....	0.26	0.29
	100.00	100.00

Clarke's average. The most notable departures are the increase in silica and the relatively strong decreases in magnesia and potassa.